4E ALUMINUM (SIC 333/5)

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified two 4-digit SIC codes in the nonferrous metals industries (SIC codes 333/335) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws equal to or greater than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes. (Facilities with these characteristics are hereafter referred to as "section 316(b) facilities".) For each of the two SIC codes, Table 4E-1 below provides a description of the industry sector, a list of products manufactured, the total number of detailed questionnaire respondents (weighted to represent national results), and the number and percent of section 316(b) facilities.

Table 4E-1: Section 316(b) Facilities in the Aluminum Industries (SIC 333/335)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents		
			Total	Section 316(b) Facilities	
				No.	%
3334	Primary Production of Aluminum	Producing aluminum from alumina and in refining aluminum by any process	31	11	35.8%
3353	Aluminum Sheet, Plate, and Foil	Flat rolling aluminum and aluminum-base alloy basic shapes, such as rod and bar, pipe and tube, and tube blooms; producing tube by drawing	57	6	10.9%
Total			***88***	***17***	***19.6%***

Source: U.S. EPA, 2000; Executive Office of the President, 1987.

4E.1 Domestic Production

Commercial production of aluminum using the electrolytic reduction process, known as the Hall-Heroult process, began in the late 1800s. The production of primary aluminum involves mining bauxite ore and refining it into alumina, one of the feedstocks for aluminum metal. Direct electric current is used to split the alumina into molten aluminum metal and carbon dioxide. The molten aluminum metal is then collected and cast into ingots. Technological improvements over the years have improved the efficiency of aluminum smelting, with a particular emphasis on reducing energy requirements. There is currently no commercially viable alternative to the electrometallurgical process (Aluminum Association, 2001).

Almost half of all U.S.-produced aluminum (48 percent of U.S. output in 2000) comes from recycled scrap. Recycling consists of melting used beverage cans and scrap generated from operations. Recycling saves approximately 95 percent of the energy costs involved in primary smelting from bauxite (S&P, 2001). In contrast to the steel industry, aluminum minimills have had limited impact on the profitability of traditional integrated aluminum producers. Aluminum minimills are not able to produce can sheet of the same quality as that produced by integrated facilities. They are able to compete only in production of commodity sheet products for the building and distributor markets, which are considered mature markets. According to Standard & Poor's, construction of new minimill capacity is unlikely given the potential that added capacity would drive down prices in the face of slow growth in the markets for minimill products (S&P, 2001). No secondary smelters (included, along with secondary smelting of other metals, in SIC code 3341) were reported in EPA's detailed questionnaire. These facilities are therefore not addressed in this profile.

Facilities in SIC code 3353 produce semifabricated products from primary or secondary aluminum. Examples of semifabricated aluminum products include (Aluminum Association, undated):

- sheet (cans, construction materials, and automotive parts);
- plate (aircraft and spacecraft fuel tanks);
- foil (household aluminum foil, building insulation, and automotive parts);
- rod, bar, and wire (electrical transmission lines); and
- extrusions (storm windows, bridge structures, and automotive parts).

U.S. aluminum companies are generally vertically integrated. The major aluminum companies own large bauxite reserves, mine bauxite ore and refine it into alumina, produce aluminum ingot, and operate the rolling mills and finishing plants used to produce semifabricated aluminum products (S&P, 2001).

a. Output

The largest single source of demand for aluminum is the transportation sector, primarily the manufacture of motor vehicles. Demand for lighter, more fuel efficient vehicles has led to increased demand for aluminum in auto manufacturing, at the expense of steel (S&P, 2001). Until five years ago, containers were the largest U.S. market for aluminum. Production of beverage cans is a major use of aluminum sheet, and aluminum has almost entirely replaced steel in the beverage can market. Other major uses of aluminum include construction (including aluminum siding, windows, and gutters) and consumer durables (USGS, 2001).

Demand for aluminum reflects the overall state of the domestic and world economies, as well as long-term trends in materials use in major end-use sectors. Because aluminum production involves large fixed investments and capacity adapts only slowly to fluctuations in demand, the industry has experienced alternating periods of excess capacity and tight supplies. The early 1980s were a period of oversupply, high inventories, excess capacity, and weak demand. By 1986, excess capacity had been closed, inventories were low, and demand increased dramatically. The early 1990s were affected by reduced U.S. demand and by the dissolution of the Soviet Union, which resulted in dramatic increases in Russian exports of aluminum. By the mid-1990s, global production had declined, demand rebounded, and aluminum prices rebounded. Subsequent increases in production reflected an overall increase in the demand for aluminum with stronger domestic economic growth, driven by increased consumption by the transportation, container, and construction sectors. The economic crises in Asian markets in the later 1990s, along with growing Russian exports, again resulted in a period of oversupply, although U.S. demand for aluminum remained strong. Sales to the automotive sector were at record levels in 1999 and 2000. Demand has declined starting in 2000, however, reflecting slower growth in both the U.S. and the world economy. In addition, there has been a major decrease in production from primary smelters affected by the Pacific Northwest energy crisis (Aluminum Association, 1999; USGS, 1999; USGS, 1998; USGS, 1994; Value Line, 2001).

Table 4E-2 shows trends in output of aluminum by primary aluminum producers and recovery of aluminum from old and new scrap. Secondary production grew from 37 percent to almost half of total domestic production over the period from 1990 to 2000. Of the total secondary production in 2000, 1,430 thousand metric tons (MT) or 42 percent, is from old scrap (discarded aluminum products), as opposed to new scrap (from manufacturing). Primary production of aluminum has showed a small net decrease over the 10-year period, and declined sharply in the first half of 2001 compared to the same period in 2000. This decrease reflects reduced domestic and world demand for aluminum, and curtailed production at a number of Pacific Northwest mills caused by the California energy crisis (S&P 2001; USGS, 2001a).

Table 4E-2: Quantities of Aluminum Produced

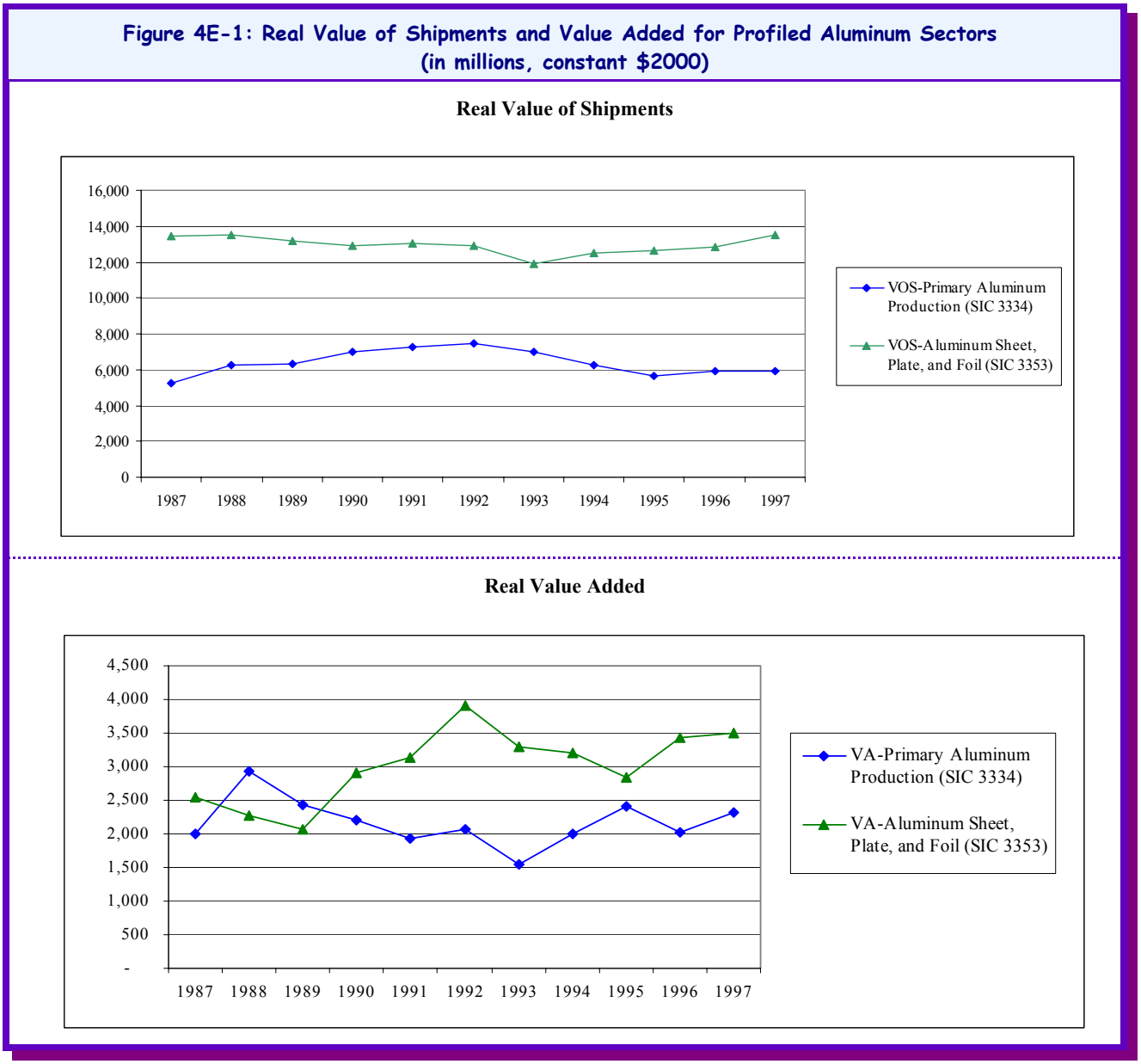
Year	Aluminum Ingot			
	Primary Production		Secondary Production (from old & new scrap)	
	Thousand MT	% Change	Thousand MT	% Change
1990	4,048	n/a	2,390	n/a
1991	4,121	1.8%	2,290	-4.2%
1992	4,042	-1.9%	2,760	20.5%
1993	3,695	-8.6%	2,940	6.5%
1994	3,299	-10.7%	3,090	5.1%
1995	3,375	2.3%	3,190	3.2%
1996	3,577	6.0%	3,310	3.8%
1997	3,603	0.7%	3,550	7.3%
1998	3,713	3.1%	3,440	-3.1%
1999	3,779	1.8%	3,750	9.0%
2000	3,688	-2.4%	3,460	-7.7%
Total percent change 1990-2000	-8.9%		*44.8%*	
Average annual growth rate	-0.9%		*3.8%*	
Jan-July 2000	2,202	n/a	2,070	n/a
Jan-July 2001	1,592	-27.7%	1,820	-12.1%

Source: USGS, 2001b; USGS, 1999; USGS, 1994;.

Value of shipments and ***value added*** are two measures of the value of manufacturing output.[1] Historical trends provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of inputs used to make the products sold.

Figure 4E-1 presents trends in real value of shipments and real value added for the primary aluminum, and aluminum sheet, plate, and foil sectors between 1987 and 1997. The producer price index for the 4-digit SIC code is used to inflate the nominal monetary values to constant 2000 dollars, as discussed in the following sub-section on prices.

Figure 4E-1: Real Value of Shipments and Value Added for Profiled Aluminum Sectors (in millions, constant $2000)



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992 and 1997.

[1] Terms highlighted in bold and italic font are further explained in the glossary.

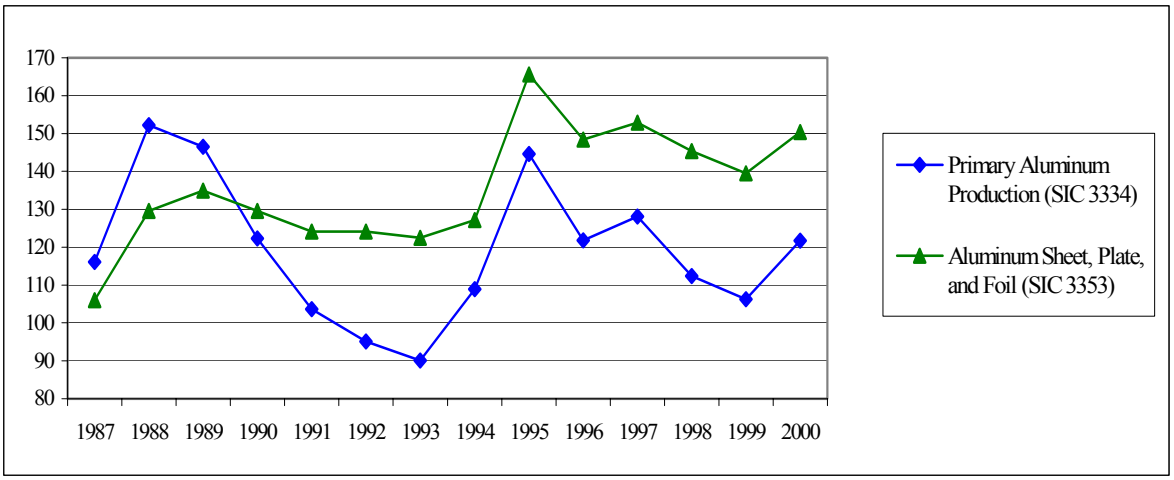
The real value of primary aluminum shipments shows generally the same pattern as the quantity data shown in Table 4E-2. Trends in production reflect trends in demand for aluminum, growth since 1990 in the percentage of domestic demand provided by imports, and increasing secondary production of aluminum, which substitutes in some but not all markets for primary production. Real value added by aluminum production excludes the value of purchased materials and services (including electricity), and shows more fluctuation since 1990 than real value of shipments.

Demand for semifinished aluminum products reflects demand from the transportation, container, and building industries. Real value of shipments of aluminum sheet, plate, and foil declined from the late 1980s through 1993, and then recovered. Demand for semifinished products has been affected by strong growth in both the container and packaging sector and the auto sector (S&P, 2001).

b. Prices

Figure 4E-2 shows the ***producer price index*** (PPI) for the 4-digit SIC code for the profiled aluminum sectors. The PPI is a family of indexes that measure price changes from the perspective of the seller. This profile uses the PPI to convert nominal monetary values to constant dollars. Sharp changes in prices reflect the cyclical nature of this industry and major changes in world markets.

Figure 4E-2: Producer Price Indexes for Profiled Aluminum Sectors



Source: BLS, 2000.

The price trends shown for primary aluminum in Figure 4E-2 reflect the fluctuations in world supply and demand discussed in the previous section. During the early 1980s, the aluminum industry experienced oversupply, high inventories, excess capacity, and weak demand, resulting in falling prices for aluminum. By 1986, much of the excess capacity had been permanently closed, inventories had been worked down, and worldwide demand for aluminum increased dramatically. This resulted in price increases through 1988, as shown in Figure 4E.2.

In the early 1990s, the dissolution of the Soviet Union had a major impact on aluminum markets. Large quantities of Russian aluminum that formerly had been consumed internally, primarily in military applications, were sold in world markets to generate hard currency. At the same time, world demand for aluminum was decreasing. The result was increasing inventories and depressed aluminum prices.

The United States and five other primary aluminum producing nations signed an agreement in January 1994 to curtail global output, in response to the sharp decline in aluminum prices. At the time of the agreement, there was an estimated global overcapacity of 1.5 to 2.0 million metric tons per year (S&P, 2000).

By the mid-1990s, production cutbacks, increased demand, and declining inventories led to a sharp rebound of prices. Prices declined again during the late 1990s, when the economic crises in Asian markets reduced the demand for aluminum (USGS, 2001b). During 2000, prices rebounded sharply despite the continuing trend of high Russian production and exports. The improved market for aluminum reflects strong worldwide demand and a decrease in U.S. production (S&P, 2001).

c. Number of facilities and firms

Data compiled by the U.S. Geological Survey suggest that the number of primary aluminum facilities and the number of firms that own them has remained fairly constant over the period 1995 through 1995, as shown in Table 4E-3.

Table 4E-3: Primary Aluminum Production - Number of Companies and Number of Plants

Year	Number of Companies	Number of Plants
1995	13	22
1996	13	22
1997	13	22
1998	13	23
1999	12	23
2000	12	23

Source: USGS, 2001a.

Statistics of U.S. Businesses covers a larger number of facilities classified under SIC 3334 than do the USGS data, and also provide data on SIC 3353 (Aluminum Sheet, Plate, and Foil). These data, shown in Table 4E-4 and 4E-5, show more fluctuation in the number of establishments and the number of firms.

Table 4E-4 shows that the number of primary aluminum facilities decreased by 30 percent between 1991 and 1995, with the majority of this decrease, 27 percent, occurring between 1991 and 1993. The number of facilities in the aluminum sheet, plate, and foil sector has shown a more consistent trend, increasing each year except in 1993.

Table 4E-4: Number of Facilities for Profiled Aluminum Sectors

Year	Primary Aluminum Production (SIC 3334)		Aluminum Sheet, Plate, and Foil (SIC 3353)	
	Number of Establishments	Percent Change	Number of Establishments	Percent Change
1989	56	n/a	61	n/a
1990	54	-3.6%	64	4.9%
1991	57	5.6%	73	14.1%
1992	52	-8.8%	73	0.0%
1993	44	-15.4%	63	-13.7%
1994	41	-6.8%	69	9.5%
1995	40	-2.4%	76	10.1%
1996	51	27.5%	81	6.6%
1997	34	-33.3%	91	12.3%
Total Percent Change 1989-1997	*-39.3%*		*49.2%*	
Average Annual Growth Rate	*-6.0%*		*5.1%*	

Source: U.S. SBA, 2000.

The trend in the number of firms over the period between 1989 and 1997 has been similar to the trend in the number of facilities in both industry sectors. Table 4E-5 presents SUSB information on the number of firms in each sector between 1989 and 1997.

Table 4E-5: Number of Firms for Profiled Aluminum Sectors

Year	Primary Aluminum Production (SIC 3334)		Aluminum Sheet, Plate, and Foil (SIC 3353)	
	Number of Firms	Percent Change	Number of Firms	Percent Change
1990	38	n/a	43	n/a
1991	41	7.9%	53	23.3%
1992	36	-12.2%	53	0.0%
1993	33	-8.3%	45	-15.1%
1994	30	-9.1%	47	4.4%
1995	30	0.0%	51	8.5%
1996	40	33.3%	56	9.8%
1997	23	-42.5%	66	17.6%
Total Percent Change 1990-1997	*-39.5%*		*53.5%*	
Average Annual Growth Rate	*-6.9%*		*6.3%*	

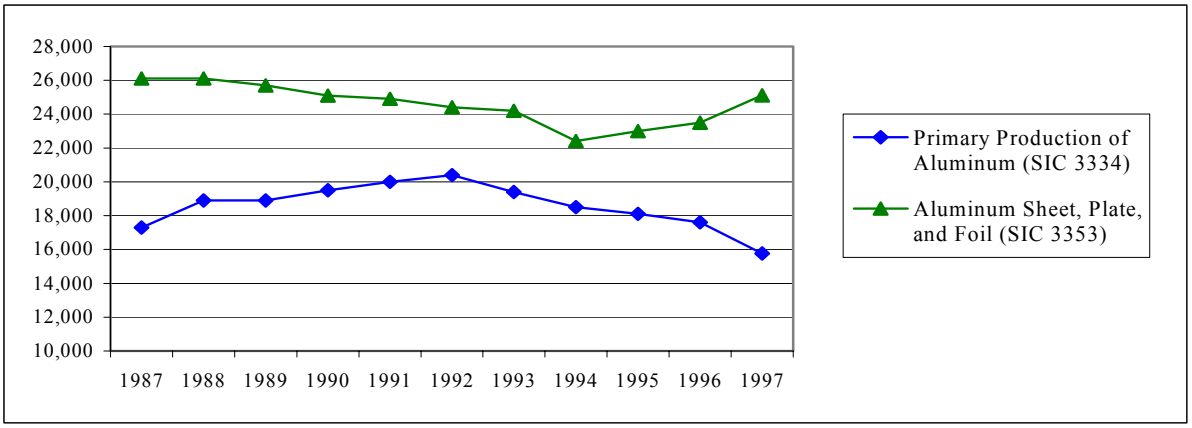
Source: U.S. SBA, 2000.

d. Employment and productivity

Figure 4E-3 below provides information on employment from the Annual Survey of Manufactures for the primary aluminum and aluminum sheet, plate, and foil sectors. Trends in primary aluminum facility employment reflect both trends in production and producers' efforts to improve labor productivity to compete with less labor-intensive minimills (McGraw-Hill, 2000). The figure shows that employment in the primary aluminum production sector has declined steadily since 1992, even in years of increased production.

Employment in the aluminum sheet, plate, and foil sector declined from 1987 through 1994, yet rose after that. There were 26,100 people employed in the aluminum sheet sector in 1987 but only 22,400 in 1994. Employment in this sector increased from its lowest level in 1994 steadily through 1997.

Figure 4E-3: Employment for Profiled Aluminum Sectors



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Table 4E-6 presents the change in real value added per labor hour, a measure of ***labor productivity***, for the primary aluminum and aluminum sheet, plate, and foil sectors between 1987 and 1997. The trend in labor productivity in both sectors has shown a fair amount of volatility over this period, reflecting variations in capacity utilization. Real value added per hour in the primary aluminum sector decreased 47 percent between 1988 and 1993 but showed a 23 percent net increase over the entire period 1987 and 1997. Real value added per hour in the aluminum sheet, plate, and foil sector saw substantial increases in the early 1990s, improving by 48 percent between 1989 and 1992 and 33 percent between 1988 and 1997.

Table 4E-6: Productivity Trends for Profiled Aluminum Sectors

Year	Primary Production of Aluminum (SIC 3334)				Aluminum Sheet, Plate, and Foil (SIC 3353)			
	Value Added (in millions, constant $2000)	Production Hours (millions)	Value Added/Hour		Value Added (in millions, constant $2000)	Production Hours (millions)	Value Added/Hour	
			$2000	Percent Change			$2000	Percent Change
1987	1,992	28	72	n/a	2,540	40	63	n/a
1988	2,929	32	92	27%	2,274	41	55	-13%
1989	2,435	30	80	-12%	2,079	41	51	-8%
1990	2,195	32	68	-15%	2,911	40	73	44%
1991	1,936	32	60	-12%	3,127	39	80	8%
1992	2,060	32	64	6%	3,914	40	98	23%
1993	1,550	29	53	-16%	3,305	39	86	-13%
1994	2,007	27	75	40%	3,199	37	88	2%
1995	2,419	28	85	15%	2,824	38	74	-15%
1996	2,019	29	71	-17%	3,422	39	88	19%
1997	2,311	26	89	25%	3,507	42	84	-5%
Total Percent Change 1987-1997	*16.0%*	*-7.1%*	*23.6%*		*38.1%*	*5.0%*	*33.3%*	
Average Annual Growth Rate	*1.5%*	*-0.7%*	*2.1%*		*3.3%*	*0.5%*	*2.9%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

e. Capital expenditures

Aluminum production is a highly capital-intensive process. Capital expenditures are needed to modernize, replace, and when market conditions warrant, expand capacity. Environmental requirements also require major capital expenditures. Possible measures required to reduce greenhouse gas (GHG) emissions may require significant expenditures by aluminum producers.

Capital expenditures in the primary aluminum and aluminum sheet, plate, and foil sectors between 1987 and 1997 are presented in Table 4E-7 below. The table shows that capital expenditures in the primary aluminum sector increased throughout the early 1990s, peaking in 1992. This period of increased capital investment was followed by a significant decrease of 54 percent between 1993 and 1995. These decreases resulted from the production cutbacks and capacity reductions implemented in response to oversupply conditions prevalent in the market for aluminum.

Capital expenditures in the aluminum sheet, plate, and foil sector have also fluctuated considerably between 1987 and 1997, with the highest in 1990, two years earlier than the primary aluminum sector. Producers of aluminum sheet, plate, and foil reduced capital expenditures by 47 percent between 1988 and 1997.

Table 4E-7: Capital Expenditures for Profiled Aluminum Sectors (in millions, constant $2000)

Year	Primary Aluminum Production (SIC 3334)		Aluminum Sheet, Plate, and Foil (SIC 3353)	
	Capital Expenditures	Percent Change	Capital Expenditures	Percent Change
1987	182	n/a	623	n/a
1988	117	-35.5%	608	-2.4%
1989	151	28.7%	615	1.2%
1990	187	23.7%	791	28.5%
1991	244	30.4%	687	-13.1%
1992	275	12.9%	507	-26.3%
1993	226	-18.0%	296	-41.5%
1994	135	-40.2%	324	9.3%
1995	128	-5.5%	344	6.2%
1996	207	62.1%	406	17.9%
1997	240	16.0%	329	-18.9%
Total Percent Change 1987-1997	*31.9%*		*-47.2%*	
Average Annual Growth Rate	*2.8%*		*-6.2%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

f. Capacity utilization

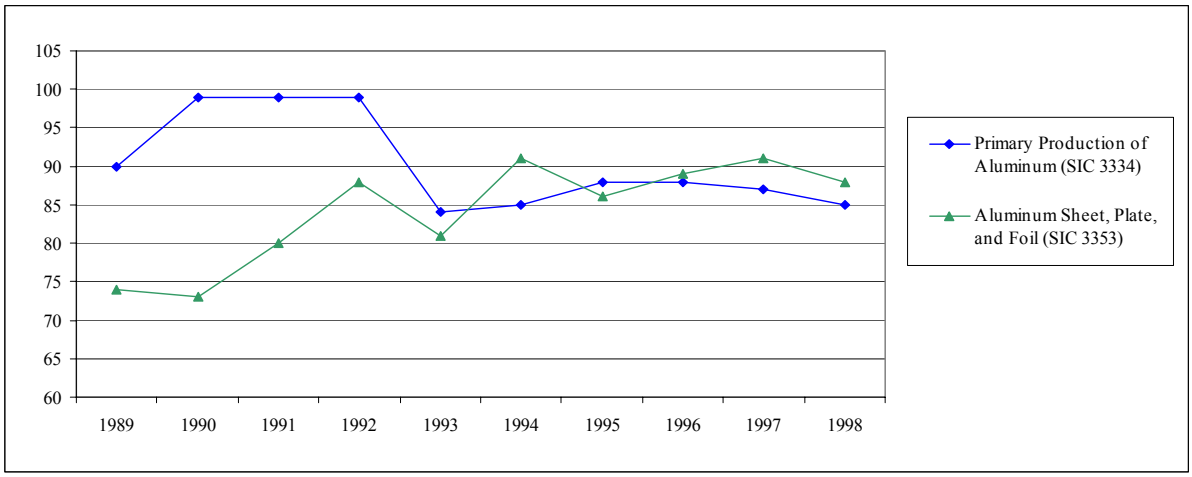
Capacity utilization measures actual output as a percentage of total potential output given the available capacity. Capacity utilization reflects excess or insufficient capacity in an industry and is an indication of whether new investment is likely.

Figure 4E-4 presents the capacity utilization index from 1989 to 1998 for the primary aluminum and aluminum sheet, plate, and foil sectors. The figure shows that for most of the 1990s, the primary aluminum industry was characterized by excess capacity. The capacity utilization index for this sector was near 100 percent between 1990 and 1992, and then decreased sharply in 1993 as large amounts of Russian aluminum entered the global market for the first time (McGraw-Hill, 1999). Capacity utilization remained low through 1996, reflecting the continued oversupply in the global aluminum market.

There continues to be a substantial amount of idled capacity in the U.S. that could be brought on-line as demand improves, which is likely to limit construction of new capacity and to limit price increases for aluminum (S&P, 2001). There has not been any new smelter capacity constructed in the United States since 1980 (McGraw-Hill, 1999). Deregulation of the U.S. power industry may encourage some smelter expansions in the U.S., if electricity prices decrease significantly once electricity markets are deregulated.

Capacity utilization in the aluminum sheet, plate, and foil sector has fluctuated but has grown overall between 1989 and 1998. This positive trend is largely driven by the continued strength of rolled aluminum products, which account for more than 50 percent of all shipments from the aluminum industry. Increased consumption by the transportation sector, the largest end-use sector for aluminum sheet, plate, and foil, is responsible for bringing idle capacity into production (McGraw-Hill 1999).

Figure 4E-4: Capacity Utilization Rates (Fourth Quarter) for Profiled Aluminum Sectors



Source: U.S. DOC, 1989-1998.

4E.2 Structure and Competitiveness

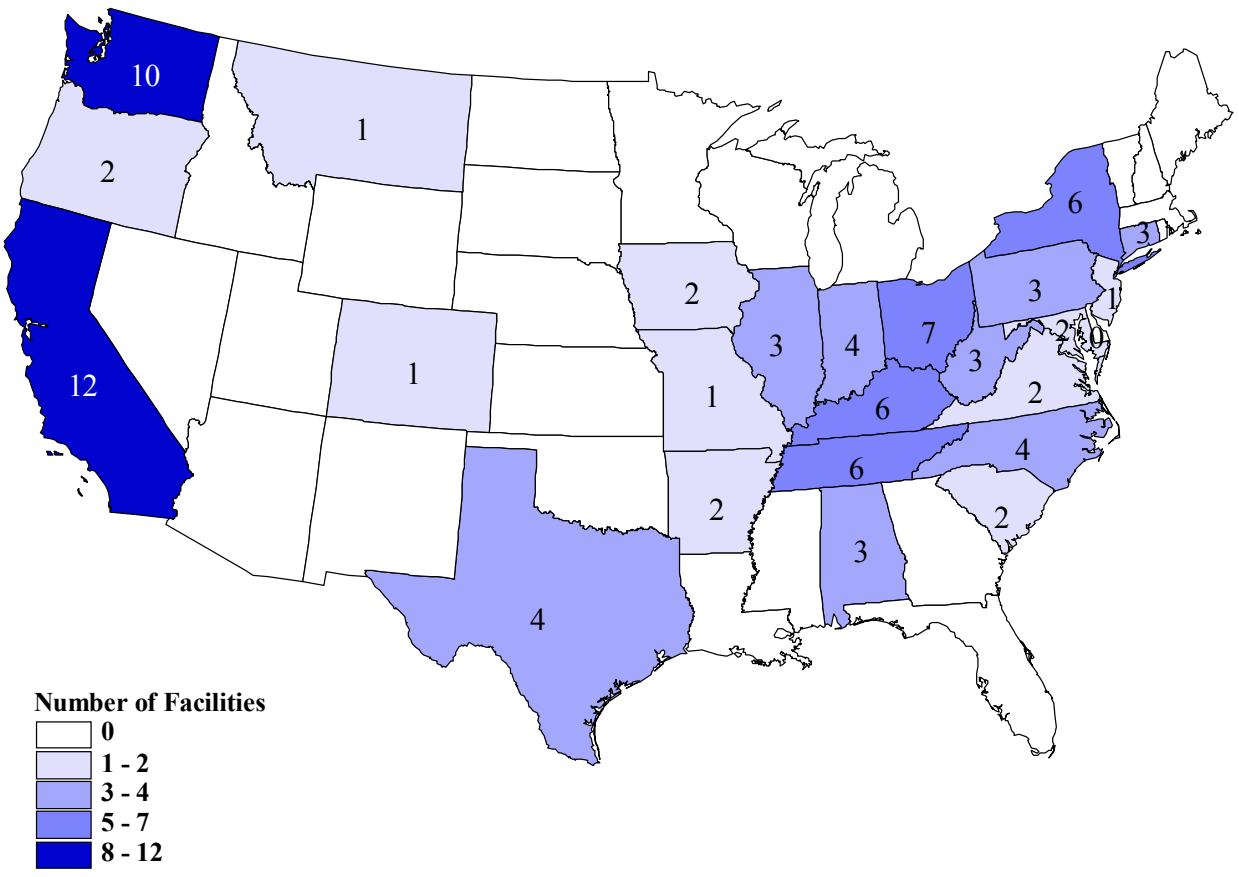
Aluminum production is a highly-concentrated industry. A number of large mergers among aluminum producers have increased the degree of concentration in the industry. For example, Alcoa (the largest aluminum producer) acquired Alumax (the third largest producer) in 1998 and Reynolds (the second largest producer) in May 2000. Some sources speculate that, with increased consolidation resulting from mergers, aluminum producers might refrain from returning idle capacity to production as demand for aluminum grows, which could reduce the cyclical volatility in production and aluminum prices that has characterized the industry in the past (S&P, 2000).

a. Geographic distribution

The cost and availability of electricity is a driving force behind decisions on the location of new or expanded smelter capacity. The primary aluminum producers (SIC 3334) are generally located in the Pacific Northwest (OR, MT, WA) and the Ohio River Valley (IL, IN, KY, MI, MO, OH, PA), where they are usually abundant supplies of hydroelectric and coal-based energy. In 1998, approximately 39 percent of the domestic production capacity was located in the Pacific Northwest and 32 percent in the Ohio River Valley. The aluminum sheet, plate, and foil industry is located principally in California and the Appalachian Region (Alabama, Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia).

Figure 4E-5 shows the distribution of all facilities in both profiled aluminum sectors (primary smelters and aluminum sheet, plate, and foil producers), based on the 1992 Census of Manufactures.

Figure 4E-5: Number of Facilities by State for Aluminum Sectors (SIC 3334 and 3353)

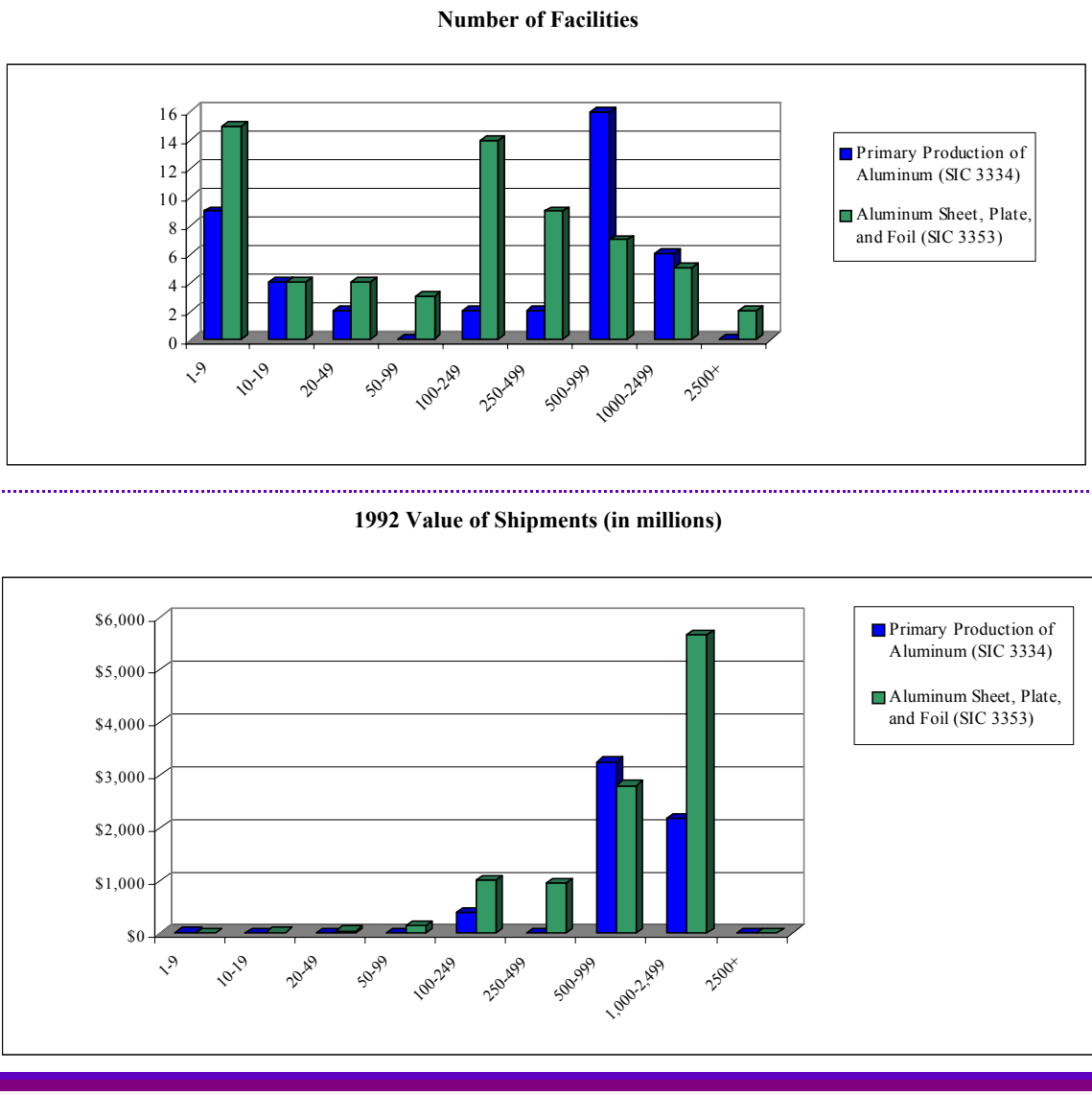


Source: U.S. DOC, 1987, 1992, and 1997.

b. Facility size

Facility size can be expressed by the number of employees and/or by the total value of shipments, with the most accurate depiction of size being a combination of both. Census data by SIC code include numerous small facilities (less than 10 employees) for the profiled aluminum sectors, as shown in Figure 4E-6. These facilities may or may not be production facilities. Value of shipments, however, are dominated by large establishments (greater than 500 employees) for both primary aluminum production and aluminum sheet, plate, and foil industries. Figure 4E-6 shows that 93 percent of the value of shipments for the primary aluminum production industry is produced by establishments with more than 250 employees. Approximately 88 percent of the value of shipments for the aluminum sheet, plate, and foil industry is produced by establishments with more than 250 employees. Establishments in the primary aluminum production and the aluminum sheet, plate, and foil sectors with more than 1,000 employees are responsible for approximately 37 and 53 percent of all industry shipments, respectively.

Figure 4E-6: Value of Shipments and Number of Facilities in 1992 by Employment Size Category for Profiled Aluminum Sectors



Source: U.S. DOC, 1987, 1992, and 1997.

c. Firm size

The Small Business Administration (SBA) defines a small firm for SIC codes 3334 and 3353 as a firm with 1,000 or fewer and 750 or fewer employees, respectively. The Statistics of U.S. Businesses (SUSB) provide employment data for firms with 500 or fewer employees and do not specify data for companies with 500-750 employees for SIC 3353 and 500-1000 for SIC 3334. Therefore, based on the data for firms with up to 500 employees,

- 8 of the 23 firms in the Primary Aluminum Production sector (SIC 3334) had less than 500 employees. Therefore, at least 35 percent of firms are classified as small. These small firms owned 8 facilities, or 24 percent of all facilities in the sector.
- 49 of the 66 firms in the Aluminum Sheet, Plate and Foil sector (SIC 3353) had less than 500 employees. Therefore, at least 74 percent of firms are classified as small. These small firms owned 49 facilities, or 54 percent of all facilities in the sector.

Table 4E-8 below shows the distribution of firms, facilities, and receipts in SIC 3334 and 3353 by the employment size of the parent firm. While there are some very small firms in each four-digit SIC code, it is unlikely that these small firms operate the facilities that are most likely to be affected by the section 316(b) requirements.

Table 4E-8: Number of Firms, Establishments and Estimated Receipts by Employment Size Category for the Profiled Aluminum Sectors, 1997

Employment Size Category	Primary Aluminum Production (SIC 3334)			Aluminum Sheet, Plate, and Foil (SIC 3353)		
	Number of Firms	Number of Facilities	Estimated Receipts ($2000 millions)	Number of Firms	Number of Facilities	Estimated Receipts ($2000 millions)
0-19	5	5	31	28	28	44
20-99	2	2	13	12	12	93
100-499	1	1	6	9	9	428
500+	15	26	6,003	17	42	12,603
Total	*23*	*34*	*6,053*	*66*	*91*	*13,168*

Source: U.S. SBA, 2000.

d. Concentration and Specialization Ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry barriers with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[2] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if an industry consists of only three firms with market shares of 60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the

[2] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios based on share of domestic production are therefore only one indicator of the extent of competition in an industry.

more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

The four largest firms in primary aluminum production accounted for 59 percent of total U.S. primary capacity in 1992. Consolidation in the industry since the early 1990s has increased concentration. With the merger of Alcoa, Inc. and Reynolds in May 2000, the single merged company accounts for 56 percent of domestic primary aluminum capacity, and the four largest U.S. producers control 74 percent of the domestic capacity reported at the end of 1999 (USGS, 1999). The three largest firms accounted for 62 percent of U.S. primary capacity (Alcoa Inc. for 44 percent, Reynolds for almost 11 percent, and Kaiser Aluminum Corp. for almost 7 percent) (S&P, 2001).[3]

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the industry's product shipments coming from facilities from the same primary industry. The coverage ratio provides an indication of how much of the production/product of interest is captured by the facilities classified in an SIC code. The reported ratios in Table 4E-9 indicate that establishments classified in SIC's 3334 and 3353 are highly specialized in production of aluminum and aluminum products, and that these establishments account for virtually all of the aluminum and semifinished aluminum product produces in the U.S.

Table 4E-9: Selected Ratios for the Profiled Aluminum Sectors

SIC Code	Year	Total Number of Firms	Concentration Ratios					Specialization Ratio	Coverage Ratio
			4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index		
3334	1987	34	74%	95%	99%	100%	1934	95%	100%
	1992	30	59%	82%	99%	100%	1456	n/a	99%
3353	1987	39	74%	91%	99%	100%	1719	96%	98%
	1992	45	68%	86%	99%	100%	1633	96%	98%

Source: U.S. DOC, 1987, 1992, and 1997.

[3] Alcoa Inc. and Reynolds merged in May 2000, following approval by the U.S. Department of Justice.

e. Foreign trade

U.S. aluminum companies have a large overseas presence, which makes it difficult to analyze import data. Reported import data may reflect shipments from an overseas facility owned by a U.S. firm. The import data therefore do not provide a completely accurate picture of the extent to which foreign companies have penetrated the domestic market for aluminum.

Table 4E-10 shows trends in export dependence and import share for aluminum ingot, semifabricated products and scrap combined, since 1990. Imports of primary aluminum rose dramatically in both 1993 and 1994, primarily due to the large exports from Russian producers. Representatives of major aluminum producing countries met in late 1993 and 1994 to address the excess global supply of primary aluminum. Those discussions resulted in the Russian Federation's agreement to reduce production by 500,000 MTs per year, and plans for other producers to cut their production and to assist Russian producers to improve their environmental performance and stimulate the development of internal demand for the Russian production (USGS Minerals Yearbook, 1994). Nonetheless, imports have continued to represent a substantial and growing proportion of U.S. demand. Exports of aluminum and aluminum products combined have remained at approximately 30 percent of domestic production since the mid-1990s, increasing slightly by 2000.

Table 4E-10: Import Share and Export Dependence: Aluminum Ignot, Semifinished, and Scrap (in thousand metric tons)

Year	Production (Primary + Recycled from Old Scrap)	Imports for Consumption	Exports	Apparent Consumption[a]	Imports as a Share of Apparent Consumption[b]	Exports as a Percent of Production[c]
1990	5,407	1,514	1,659	5,264	28.8%	30.7%
1991	5,441	1,490	1,760	5,040	29.6%	32.3%
1992	5,652	1,730	1,450	5,730	30.2%	25.7%
1993	5,325	2,540	1,210	6,600	38.5%	22.7%
1994	4,799	3,380	1,370	6,880	49.1%	28.5%
1995	4,885	2,980	1,610	6,300	47.3%	33.0%
1996	5,147	2,810	1,500	6,610	42.5%	29.1%
1997	5,133	3,080	1,570	6,720	45.8%	30.6%
1998	5,213	3,550	1,590	7,090	50.1%	30.5%
1999	5,349	4,000	1,640	7,740	51.7%	30.7%
2000[d]	5,300	4,200	1,750	7,900	53.2%	33.0%
Total Percent Change 1990-2000	*-2.0%*	*177.4%*	*5.5%*	*50.1%*		
Average Annual Percent Change	*-0.2%*	*10.7%*	*0.5%*	*4.1%*		

[a] Calculated by USGS as domestic primary metal production + recovery from old aluminum scrap + net import reliance. Net import c reliance calculated by USGS as imports - exports + adjustments for Government and industry stock changes.
[b] Calculated by EPA as imports divided by apparent consumption.
[c] Calculated by EPA as exports divided by domestic production (primary + recovery from old aluminum scrap)
[d] Estimated

Source: USGS, 2001a; USGS, 1999; USGS, 1997; USGS, 1994; USGS, Historical Statistics for Mineral Commodities in the US .

Table 4E-11 shows trends in exports and imports separately for aluminum metal and alloys and for semifinished products separately. This table shows that imports have grown substantially in both categories between 1993 and 2000, but that the composition of exports has shifted from primary aluminum (exports of which have declined substantially) to semifinished (exports of which have grown substantially over the period shown). Exports and imports of both product categories declined sharply in the first half of 2001, due to the reduction in demand in the U.S. and abroad.

Table 4E-11: Trade Statistics for Aluminum and Semifabricated Aluminum Products (in thousand metric tons)

Year	Metals and Alloys, Crude		Plate, Sheets, Bars, Strip, etc.	
	Import Quantities	Export Quantities	Import Quantities	Export Quantities
1993	1,840	400	400	594
1994	2,480	339	507	719
1995	1,930	369	622	812
1996	1,910	417	498	760
1997	2,060	352	562	882
1998	2,400	265	649	893
1999	2,650	318	735	907
2000	2,490	273	791	907
Total Percent Change 1993-2000	*35.3%*	*-31.8%*	*97.8%*	*52.7%*
Average Annual Growth Rate	*4.4%*	*-5.3%*	*10.2%*	*6.2%*
Jan-June 2000	1,340	145	398	456
Jan-June 2001	1,210	102	336	426
Percent Change 2000-2001	*-9.7%*	*-29.7%*	*-15.6%*	*-6.6%*

Source: USGS, 2001b; USGS, 1999; USGS, 1994.

4E.3 Financial Condition and Performance

The production of primary aluminum is an electrometallurgical process, which is extremely energy intensive. Electricity accounts for approximately 30 percent of total production costs for primary aluminum smelting. The aluminum industry is therefore a major industrial user of electricity, spending more than $2 billion annually. The industry has therefore pursued opportunities to reduce its use of electricity as a means of lowering costs. In the last 50 years, the average amount of electricity needed to make a pound of aluminum has declined from 12 kilowatt hours to approximately 7 kilowatt hours. (Aluminum Association, undated).

Like integrated steel mills, aluminum manufacturers require very large capital investments to transform raw material into finished product. Because of the high fixed costs of production, earnings can be very sensitive to production levels, with high output levels relative to capacity needed for plants to remain profitable.

Operating margin measures the relationship between revenues and operating costs. Relatively small changes in output or prices can have large positive or negative impacts on operating margins, given the high fixed capital costs in the aluminum industry (S&P, 2000). Operating margins do not reflect the changes of capital costs, however, and therefore are only a rough measure of profitability.

Table 4E-12 below shows trends in operating margins for the primary aluminum and aluminum sheet, plate, and foil sectors between 1987 and 1997. The table shows considerable volatility in the trends for each sector. Operating margins for the primary aluminum sector decreased between 1988 and 1993, reflecting the conditions of oversupply in the market that led to decreasing shipments from U.S. producers (McGraw-Hill, 2000). The increase in value of shipments from 1987 to 1992 is attributed to the increase in payroll and cost of materials. The operating margin Lower prices for aluminum were responsible for lower material costs for the aluminum sheet, plate, and foil sector and a modest increase in operating margins between 1989 and 1992.

Table 4E-12: Operating Margins for the Profiled Aluminum Sectors (in millions, constant $2000)

Year	Primary Aluminum Production (SIC 3334)				Aluminum Sheet, Plate, and Foil (SIC 3353)			
	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin
1987	$5,247	$3,196	$596	27.7%	$13,475	$11,126	$1,294	7.8%
1988	$6,242	$3,335	$535	38.0%	$13,516	$11,518	$1,118	6.5%
1989	$6,348	$3,931	$596	28.7%	$13,179	$10,778	$1,107	9.8%
1990	$6,999	$4,821	$746	20.5%	$12,906	$10,075	$1,185	12.8%
1991	$7,275	$5,331	$911	14.2%	$13,056	$9,482	$1,212	18.1%
1992	$7,485	$5,409	$1,031	14.0%	$12,905	$8,814	$1,229	22.2%
1993	$6,984	$5,424	$983	8.3%	$11,875	$8,460	$1,257	18.2%
1994	$6,238	$4,248	$790	19.2%	$12,506	$9,710	$1,160	13.1%
1995	$5,620	$3,281	$627	30.5%	$12,637	$9,910	$936	14.2%
1996	$5,928	$3,832	$749	22.7%	$12,812	$9,155	$1,094	20.0%
1997	$5,914	$3,522	$672	29.1%	$13,531	$9,939	$1,180	17.8%

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

4E.4 Facilities Operating Cooling Water Intake Structures

In 1982, the Primary Metals industries as a whole (including Steel and Non-ferrous producers) withdrew 1,312 billion gallons of cooling water, accounting for approximately 1.7 percent of total industrial cooling water intake in the United States. The industry ranked 3rd in industrial cooling water use, behind the electric power generation industry, and the chemical industry (1982 Census of Manufactures).

This section presents information from EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from a water of the United States;
- they hold an NPDES permit;
- they have a design intake flow of equal to or greater than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the section 316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "section 316(b) facilities."

a. Cooling water uses and systems

Information collected in EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* found that 11 out of 31 primary aluminum producers (35 percent) and 6 out of 57 aluminum sheet, plate, and foil manufacturers (11 percent) meet the characteristics of a section 316(b) facility. Aluminum section 316(b) facilities use cooling water for a combination of purposes, including contact and noncontact production line or process cooling, electricity generation, and air conditioning:

- All section 316(b) primary aluminum producers use cooling water for production line (or process) contact or noncontact cooling. Thirty percent also use cooling water for air conditioning, 11 percent use cooling water for electricity, and 60 percent have other uses for cooling water.

- All section 316(b) aluminum sheet, plate, and foil manufacturers use cooling water for production line (or process) contact and noncontact cooling. Fifty percent use cooling water for air conditioning, and 50 percent have other uses for cooling water.

Table 4E-13 shows the distribution of existing section 316(b) facilities in the profiled aluminum sector by type of water body and cooling system. The table shows that three-quarters of the section 316(b) facilities employ either a once-through cooling system (13, or 76%) and one-quarter use a recirculating system (4, or 24%). Ten of the 11 section 316(b) primary aluminum producers obtain their cooling water from a freshwater stream or river. The other section 316(b) primary producer draws from a lake or reservoir. All of the section 316(b) aluminum sheet, plate, and foil manufacturers obtain their cooling water from either a freshwater stream or river. Ninety-four percent (16 facilities) of all section 316(b) aluminum facilities withdraw their cooling water from a freshwater stream or river.

Table 4E-13: Number of Section 316(b) Facilities by Water Body Type and Cooling System Type for the Profiled Aluminum Sectors

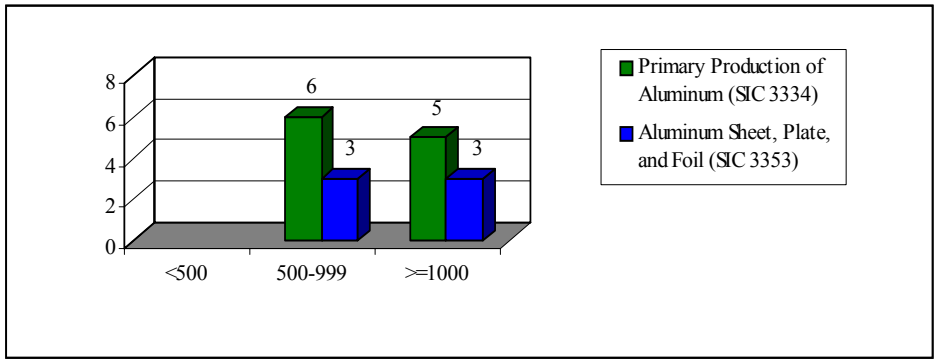
Water Body Type	Cooling System						
	Recirculating		Combination		Once-Through		Total
	Number	% of Total	Number	% of Total	Number	% of Total	
Primary Production of Aluminum (SIC 3334)							
Freshwater Stream or River	0	0%	0	0%	10	100%	10
Lake or Reservoir	1	100%	0	0%	0	0%	1
Total	*1*	*9%*	*0*	*0%*	*10*	*91%*	*11*
Aluminum Sheet, Plate, and Foil (SIC 3353)							
Freshwater Stream or River	3	50%	0	0%	3	50%	6
Total	*3*	*50%*	*0*	*0%*	*3*	*50%*	*6*
Total for Profiled Aluminum Facilities (SIC 3334, 3353)							
Freshwater Stream or River	3	19%	0	0%	13	81%	16
Lake or Reservoir	1	100%	0	0%	0	0%	1
Total	**4**	**24%**	**0**	**0%**	**13**	**76%**	**17**

Source: U.S. EPA, 2000.

b. Facility Size

Figure 4E-7 shows the number of section 316(b) facilities by employment size category for the profiled aluminum sectors. All of the establishments in both SIC codes employ over 500 people, and 45 percent of primary aluminum producers and 50 percent aluminum sheet, plate, and foil manufacturers employ over 1,000 employees.

Figure 4E-7: Number of Section 316(b) Facilities by Employment Size for the Profiled Aluminum Sectors



Source: U.S. EPA, 2000.

c. Firm Size

EPA used the Small Business Administration (SBA) small entity size standards to determine the number of existing section 316(b) profiled aluminum industry facilities owned by small firms. Firms in the Primary Production of Aluminum sector (SIC 3334) are defined as small if they have 1000 or fewer employees; firms in the Aluminum Sheet, Plate, and Foil sector (SIC 3353) are defined as small if they have 750 or fewer employees. Table 4E-14 shows that all of the section 316(b) primary aluminum producers are owned by large firms. The same is true for all the section 316(b) aluminum sheet, plate, and foil producers.

Table 4E-14: Number of Section 316(b) Facilities by Firm Size for the Profiled Aluminum Sectors

SIC Code	Large		Small		Total
	Number	% of SIC	Number	% of SIC	
3334	11	100%	0	0%	11
3353	6	100%	0	0%	6
Total	*17*	*100%*	*0*	*0%*	*17*

Source: U.S. EPA, 2000; D&B, 2001.

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